The TestOps Manifesto
A Blueprint for Connected, Agile Design and Test

PATHWAVE

In 2001, 17 software engineers met at a resort in Snowbird, Utah. On that day, the *Manifesto for Agile Software Development* was born, forever changing the way software would be developed. Two decades later, a similar transformation is underway in electronic design and test. The benefits are profound: Companies that embrace DevOps workflows report 29% greater productivity from their engineers. TestOps – DevOps for design and test – promises similar benefits.
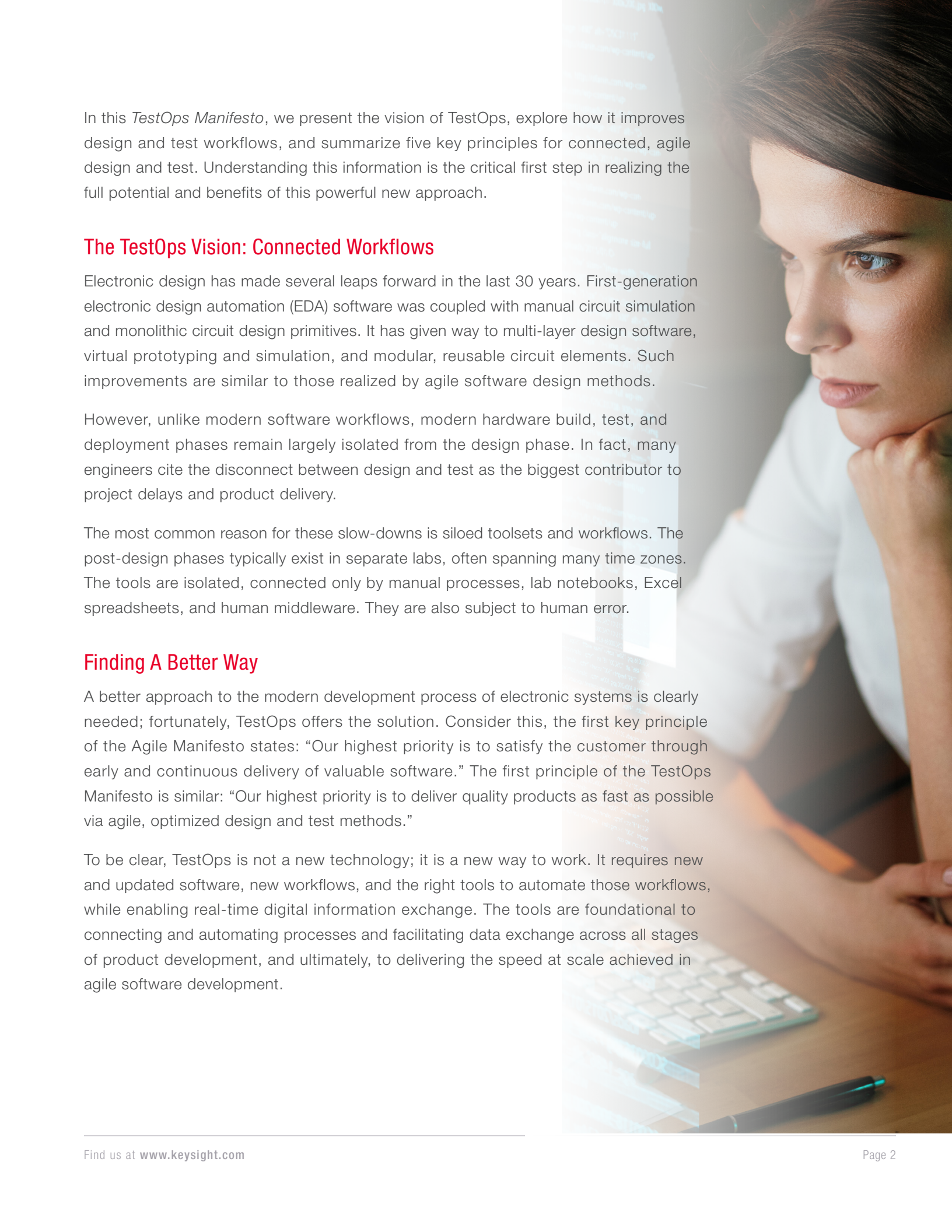
Connected, Agile Design and Test

Connected, agile design and test is a transformational way to approach the development of electronic systems. It combines new software, new workflows, and powerful automation tools, in a way that transforms legacy processes and yields substantial productivity and equipment utilization improvements. The approach moves organizations from siloed design and test steps, to agile, connected workflows. The benefits mirror those of agile software design and DevOps: faster device design, translation of design parameters into test requirements, and execution and validation of test results. When coupled with automation, what results is a new development culture known as TestOps.

In this TestOps Manifesto, we present the vision of TestOps, explore how it improves design and test workflows, and summarize five key principles for connected, agile design and test. Understanding this information is the critical first step in realizing the full potential and benefits of this powerful new approach.

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The TestOps Vision: Connected Workflows

Electronic design has made several leaps forward in the last 30 years. First-generation electronic design automation (EDA) software was coupled with manual circuit simulation and monolithic circuit design primitives. It has given way to multi-layer design software, virtual prototyping and simulation, and modular, reusable circuit elements. Such improvements are similar to those realized by agile software design methods.

However, unlike modern software workflows, modern hardware build, test, and deployment phases remain largely isolated from the design phase. In fact, many engineers cite the disconnect between design and test as the biggest contributor to project delays and product delivery.

The most common reason for these slow-downs is siloed toolsets and workflows. The post-design phases typically exist in separate labs, often spanning many time zones. The tools are isolated, connected only by manual processes, lab notebooks, Excel spreadsheets, and human middleware. They are also subject to human error.

Finding A Better Way

A better approach to the modern development process of electronic systems is clearly needed; fortunately, TestOps offers the solution. Consider this, the first key principle of the Agile Manifesto states: "Our highest priority is to satisfy the customer through early and continuous delivery of valuable software." The first principle of the TestOps Manifesto is similar: "Our highest priority is to deliver quality products as fast as possible via agile, optimized design and test methods."

To be clear, TestOps is not a new technology; it is a new way to work. It requires new and updated software, new workflows, and the right tools to automate those workflows, while enabling real-time digital information exchange. The tools are foundational to connecting and automating processes and facilitating data exchange across all stages of product development, and ultimately, to delivering the speed at scale achieved in agile software development.

TestOps: DevOps-Style Automation for Design and Test

The second principle of the Agile Manifesto states: "Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage." The second principle of the TestOps Manifesto is similar: "Embrace agile methods to achieve time-to-market advantage throughout the R&D lifecycle."

Those familiar with the history and evolution of EDA software already know how circuit design tools delivered capabilities essential for agile hardware design. Now, it is becoming possible to integrally connect those initial designs to the later phases of design and test, from prototyping through manufacturing.

The agile software development concept was conceived in 2001, but it wasn't until 2009 that DevOps was born. Two Flickr employees, John Allspaw and Paul Hammond, proposed DevOps: an environment where agile software development and operations are combined in a seamless, transparent, and fully integrated workflow. The TestOps Manifesto lays out an approach to extend the well-understood DevOps strategy to engineering design and test workflows.

Achieving a TestOps environment requires changes in process, tools, and culture. With the right tools and processes in place, measurable improvements in three critical areas can be realized:

- **Reduced engineering time.** Decreased time spent creating and calibrating development and manufacturing test scripts.
- **Improved equipment utilization.** Increased equipment utilization resulting from faster configuration changes, increased reuse of test scripts, and script improvements derived from analysis of test sequence data.
- **Improved throughput.** Improved throughput resulting from faster data acquisition, data processing, and margin analysis.

Principles of Connected, Agile Design and Test

There are five key principles for connected, agile design and test. These include:

1. Common Data Exchange and Data Management

The foundation of a TestOps workflow is a method for capturing and exchanging data between different tools and people in the workflow. This may include simulated waveform files, test scripts and parameters, configuration information, target design performance parameters, and of course, test results, as well as margin and threshold analysis of pass/fail conditions.

The workflow tools must be able to open and interpret these tools and enable meaningful interactions—both with the test equipment and end user. Ideally, these tools will also transform traditionally analog human actions, such as transferring notes manually, into digital workflows from human operators. This would include details such as script revision annotations, test algorithm or test procedure assumptions, and observed details related to test methods and operations.

Data exchange is also crucial for reducing design cycle time. In a TestOps workflow, the ability to natively exchange and correlate data in software can substantially reduce overall design time.

> According to a recent Keysight survey[1], 9 out of 10 companies revealed that it takes months to correlate data manually.

2. Open APIs and Open-Source Automation Tools

Common data exchange and data management starts with a set of application programming interfaces (APIs) that enable the exchange of data between multiple software components, both vendor-supplied and homegrown. An open, extensible format for data exchange, such as XML or JSON, enables rapid adaptation as tests and tools emerge.

An open-source approach provides the opportunity for rapid prototyping and refinement, while leveraging best-in-class components from a wide ecosystem of industry partners. Organizations can transform legacy homegrown test suites by adopting open, standards-based test and measurement libraries. By doing so, they gain the benefits of best-in-class measurement science, world-class test libraries, and a cloud-scalable software architecture.

> Today, the average organization spends 2+ hours per week coding solutions to keep test processes running and data flowing.[1] With open and reusable components, those hours could instead be spent optimizing test throughput.

3. Best-in-Class Measurement Science

Every electronic device needs to pass a minimum set of compliance and electromagnetic interference (EMI) tests. Most devices are required to pass far more rigorous standards compliance tests to guarantee interoperability. From memory and processor busses, to wireless communications and automotive networks, nearly every device must pass one or more industry-standard compliance tests.

Industry standards are constantly evolving and advancing. To deliver best-in-class measurement science, the test environment must support and implement the latest standards. That environment should enable seamless deployment of those

test suites on appropriate test hardware. Just as critically, test results should be stored and correlated against a specific release of a standard. This ensures accurate testing, especially in early-to-market development opportunities where industry standards are still unfinished and rapidly changing.

Correlation time can be reduced by reusing the same optimized algorithms at each step in the design, simulation, and test stages. Further time reduction comes from moving manual confirmations into an automated workflow. Understanding the algorithms used to create test waveforms and simulations helps automate correlation of measured results in the physical world. This level of integration is only possible when test and measurement platforms share common measurement science.

The path to a more efficient workflow starts with an integrated platform that brings the right tools together. Consistent, accurate, integrated measurement science between design, simulation, and validation phases is essential to accelerating product design.

4. Scalable, Run-Anywhere Architecture

As designs grow in complexity, the time required at each stage of the design cycle also grows. Hundreds, or even thousands, of simulation hours go into product design before the first prototype is ever built. Test matrices for prototype validation grow longer as device manufacturers pack more technologies into every device, requiring both protocol conformance and coexistence test cases. Today's 5G wireless mobile devices, for example, require 20x more tests than a 4G device from the previous decade.

Test volume is not the only challenge. Processing the volumes of data acquired during test also slows the design and test cycle. In traditional design and test environments, data extraction and data processing both happen on the test equipment. Modern design and test systems generate massive amounts of data, and local processing is no longer the most efficient option. Separating the data acquisition plane from the data processing plane introduces the possibility of processing data using cloud-scale resources.

Enabling cloud-scale processing requires a run-anywhere software architecture. This means that software engines must be capable of deploying on desktops, embedded on instruments, on enterprise servers, or at cloud scale on public or private cloud services. A scalable, run-anywhere architecture enables organizations to deploy in the environment most optimal for their design and test requirements.

5. Integrated Analytics and Visualization

Continuous performance monitoring and analysis lets engineers find and fix problems quickly. A typical test and measurement team can have up to 200 pieces of equipment running simultaneously. As devices become more complex, the size of the test matrix increases. Storing, managing, and correlating these large datasets can frustrate the best engineer, and slow a project to a crawl.

According to the Keysight survey,[1] 91% of organizations use 3 or more different design tools with little to no integration in the workflow. 93% of design and test engineers believe that an integrated design and test suite can accelerate time-to-market.

Over half of engineers surveyed by Keysight[1] reported that EMI compliance and interference analysis was the most time-consuming aspect of simulation. Areas like these are ripe for a run-anywhere architecture.

Modern automation and analytics tools, built with powerful computing and storage capabilities, make real-time monitoring effortless. Engineers want data analytics software that manages their data and presents it in an easily understood format. Studies show that engineers spend more than eight hours per week simply finding and using data they need.[2]

Continuing integration (CI) and continuous delivery (CD) are now common terms in DevOps culture. These critical concepts translate directly to the world of test automation. From test design and deployment, to unit testing and validation, the concepts of DevOps translate directly to the test environment. TestOps engineers must embrace a "fail fast" posture and iterate to drive constant improvement in test sequences, while eliminating state failures that stall rapid test and analysis.

Conclusion

The principles of common data exchange, open APIs, best-in-class measurement science, scalable run-anywhere architecture, and integrated analytics and visualization form the foundation for a transformational new way of connecting design and test workflows. This approach is driving new levels of efficiency across all stages of the product lifecycle. But maximizing these capabilities requires more than just hardware and software – it requires culture change. TestOps is the culture that enables connected, agile design and test.

Are you ready to embrace a TestOps culture in your organization? Visit www.keysight.com/find/pathwave to learn how Keysight's award-winning design and test software can help you on your journey to more connected, agile design and test workflows today.

According to IBM, resolving bugs in production is 15 times more expensive than fixing them during testing.[3] Fixing problems before they get too far down the workflow saves both time and money. DevOps has proven this axiom. It makes even more sense in a hardware product development environment.

1   Removing Time-to-Market Barriers for Electronic Devices. Dimensional Research Survey on behalf of Keysight Technologies, January 2019

2   https://www.engineering.com/ResourceMain.aspx?resid=615

3   https://www.riverbed.com/blogs/three-ways-performance-monitoring-gives-devops-a-boost.html

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